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Mr. William F. Caton
Acting Secretary
Federal Communication Commission
1919 M. Street, NW
Washington, DC 20554

RE: ET Docket No. 94-124 RM-8308

Dear Mr. Caton:

Texas Instruments Incorporated submits the attached in response to the comments filed in the above referenced proceedings.

Please direct any questions with respect to this matter to the undersigned.

Sincerely,

Eugene A. Robinson

Eugene A. Robinson
Senior Fellow
Communications & Electronic Systems
Texas Instruments Incorporated

Enclosure

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TI-29617C

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Amendments of Parts 2 and 15	)	ET Docket No. 94-124
of the Commission's Rules to Permit	)	RM-8308
Use of Radio Frequencies Above 40 GHz	)	
for New Radio Applications	)	

[redacted]

Comments of Texas Instruments
In response of the comments to the referenced proceedings.

Texas Instruments hereby files comments in response to the comments provide by 28 GHz satellite interest groups in the above referenced proceedings. Texas Instruments has an interest in the development of Local Multipoint Distribution Service ("LMDS"), a new and revolutionary wireless means for the delivery of two-way video, voice and data service with innumerable public interest benefits in the 27.5 to 29.5 GHz band. Texas Instruments also commends the Federal Communications Commission for their action to open new radio applications in the frequency bands above 40 GHz.

SUMMARY

A number of the FSS interest groups, (Teledesic Corporation, Hughes Communications Galaxy, Inc. and NASA) has chosen to comment on the ET Docket No. 94-124 RM-8308 in the matter of Amendments of Parts 2 and 15 of the Commission's Rules to permit use of radio frequencies above 40 GHz for new radio applications in such a matter to recommend that the 40 GHz spectrum could be used to resolve the 28 GHz issues that were not resolved by the 28 GHz Negotiated Rulemaking Committee (NRMC). It is interesting to note the unified response from this group which during the 28 GHz proceedings refused to explore and consider means to resolve technical incompatibilities in order to accommodate the co-frequency sharing between the FSS and LMDS systems. It appears to be that their solution is to move the 28 GHz LMDS systems to the 40 GHz spectrum with a claim of a "win-win situation" with such a move. They also claim that this could be done with no difficulties to LMDS since the "frequencies above 40 GHz would be technically and operationally similar to the services now proposed." It is clear that this group is not aware of the technical and operational differences and the economic impact that a move to the higher frequencies would impose on the LMDS systems. Texas Instruments fully supports the idea of a frequency auction at 28 GHz to allow the American public interest to be supported and decided by the free market place.

The 28 GHz NRMC did not fail to devise or solve the interference conflicts between those parties who participated and attempted to find solutions for co-frequency sharing. The LMDS participants and Motorola with their Iridium system were able to reach both technical and operational agreements for the two systems to co-share the 28 GHz frequency. Also, the LMDS participants were able to modify their system parameters and their operations such that no interference would exist with the satellite systems. However, the FSS satellite group were unwilling to agree to a small increase (3 dB) to the minimum value of their transmit power to improve their satellite link signal to noise ratio and provide margin against potential interference even though this is the manner in which they would normally operate their systems. Likewise, they refused to operate their systems with a minimum elevation angle of 20 to 30 degrees, a standard practice with FSS operation, to minimize interference into the LMDS systems or to consider other interference mitigation techniques that were suggested.

The FSS proponents claim that there is no technical differences in the operation or equipment that would be present at 40 GHz in lieu of 28 GHz operation but their own studies have highlighted the differences which are not as insignificant as they claim. The use of 40 GHz in European MVDS can not be used for comparison to LMDS in the United States because of rain differences between the two continents. The additional loss due to rain fall rates in the United States is a significant factor that must be resolved by the LMDS system designer and operator. The FSS proponents have chosen to focus on the conditions that exist in the northeast area of the United States and have not considered the quality of the transmission path that would result with the rain fall rates in the northeast or elsewhere in the United States.

Thus, the FSS interest, consisting of Teledesic, Hughes, and NASA, have filed comments which proposes to have the FCC move the LMDS systems to the 40 GHz spectrum with the following claims.

- Win-win situation which allows the LMDS proponents the spectrum required leaving the 28 GHz spectrum to the FSS proponents.

- That technically and operationally the 40 GHz band is comparable with 28 GHz operation without significant differences.

- LMDS allocation at 40 GHz would be consistent and equivalent to the European allocation for MVDS.

However, these claims can not be supported by Texas Instruments as being unbiased claims for the reasons presented in the following sections.

- LMDS MOVE TO 40 GHZ WOULD NOT BE A "WIN-WIN SITUATION"

The move of LMDS from the 28 GHz band to 40 GHz would not be a win-win situation for the LMDS and FSS proponents but rather a one-sided win for the FSS proponents who would like to hold exclusive use for some future time the 28 GHz band without the encumbrance of an auction. The move of LMDS from the 28 GHz band would create a situation that would delay the implementation for an indefinite time due to the technical constraints imposed on the equipment for operation at 40 GHz and the limitations imposed on the coverage range/cell size of an LMDS Node at the higher frequency. The higher frequency operation would impose increased difficulty in frequency generation, stability and purity necessary for the operation of a LMDS system. Also, there would be the increased power requirements necessary to counter the increase in rain attenuation and the associated cost assuming that it would be feasible to generate those power levels economically. The technical maturity at 40 GHz is a number of years (5 to 10 years) behind that which exist today at 28 GHz. These factors are recognized by the FSS proponents in their studies but are were considered to be insignificant for the LMDS system developer or operator in their comments. Clearly, the move of LMDS to the higher frequency 40 GHz band would not be considered a win-win situation for the LMDS system developer or operator.

- TECHNICALLY AND OPERATIONALLY THE 40 GHZ BAND IS NOT COMPARABLE WITH 28 GHZ OPERATION.

The FSS proponents have proposed in their comments that technically and operationally the 40 GHz band "is comparable with 28 GHz operation." The following reviews each of the individual comments and provides the LMDS developers view.

The NASA comments to ET Docket No. 94-124 RM-8308 states that examination of the design of a leading contender for LMDS (Suite 12) proves conclusively that there is virtually no difference in the operation of LMDS at the higher frequency. They identify propagation effects that need to be examined as functions of frequency as

-attenuation due to atmospheric gasses, and
-attenuation due to precipitation.

NASA concludes that the attenuation due to water vapor and oxygen absorption over the distance of 4.8 Km from the Node hub to the subscriber is a mere 0.25 dB higher at the 40 GHz higher frequency and is an insignificant difference.

Texas Instruments is in general agreement with NASA's conclusion of the slight 0.25 dB increase in water vapor and oxygen absorption at 40 GHz. However, as a system developer and equipment manufacturer contending with 2 to 3 dB increase in system receiver noise figure, over that obtainable at 28 GHz, any increase in signal loss is not dismissed lightly since it impacts system margins, performance and ultimately manufacturing yields and cost.

NASA also calculated the rain fall attenuation in the New York area as 2.7 dB/km at a rain rate of 14.9 mm/hr at 28 GHz with a system design margin of 13 dB to accommodate the rain attenuation. They go further to assume that at 41.5 GHz additional hub antenna gain would be available to allow a system design margin of 16 dB to compensate for attenuation due to rain of 3.33 dB/km with a rainfall rate of 10.5 mm/hr. They propose that their analysis indicates that there is an insignificant difference in the availability of the LMDS hub to subscriber link at 41.5 GHz compared to that at 28.5 GHz.

There are several flaws and errors that exist in this line of thinking proposed by NASA to show an insignificant difference in 28 GHz vs 41.5 GHz operation of LMDS. The first error is assuming that the hub which uses a polarized omni or sector coverage antenna with controlled sidelobes would have significantly higher gain at the higher frequency. They also have assumed that a lower rainfall rate of 10.5 mm/hr could be used in lieu of the original 14.9 mm/hr rain rate for which the 28 GHz system was designed to accommodate.

Texas Instruments must look at the rain attenuation differences between 28 GHz and 40 GHZ through out the United States to provide a system that would provide a reliable and high level of quality for users of our systems. If one reviews the following table an appreciation of the differences in system requirements can be gained.

Frequency\Rain Rate	25 mm/hr 1 inch/hr	50 mm/hr 2 inches/hr	100 mm/hr 4 inches/hr	150 mm/hr 5 inches/hr
28 GHz	5.5 dB/km	12 dB/km	20 dB/km	30 dB/km
40 GHz	7.2 dB/km	15 dB/km	25 dB/km	36 dB/km
Difference (28 vs 40GHz)	1.7 dB/km	3 dB/km	5 dB/km	6 dB/km
5Km Hub radius loss at 40GHz	8.5 dB	15 dB	25 dB	30 dB

Thus, it can be seen that the difference in rain attenuation between 28 GHz and 40 GHz does produce a significant difference that must be accommodated if one would attempt to deploy an LMDS system at 40 GHz. The system designer must either increase the EIRP of the hub or reduce the range between the hub and the subscriber or a combination of these two options. The increased rain attenuation at 40 GHz will result in increased system cost with a lower system availability, reliability and quality. All of these factors work against the deployment of a LMDS system at 40 GHz.

NASA's claim that there is an insignificant difference in the availability of the LMDS hub to subscriber link at 41.5 GHz compared to that at 28.5 GHz is not the case when extended to the general case of operation through out the United States. Thus, it would be a serious error to assume that LMDS could be moved to 40 GHz operation without serious consequences.

Hughes Communications Galaxy commented that "frequencies above 40 GHz will be technically and operationally similar to the services now proposed in the 28 GHz band for LMDS, such as the delivery of video, voice and data services to a vast number of subscribers in a large geographic area". They also go on to state that "LMDS can be accommodated at 40 GHz because that band offers essentially the same performance characteristics as the 28 GHz band". They do recognize, to a degree, the increased rain attenuation with their statement, "Although the effects of rain are some what more severe at 40 GHz than they are at 28 GHz, rain losses at 40 GHz can be overcome through maintaining flexibility in system design".

Hughes does recognize the wide range of service that could be offered to the public with their statement. However, they have underestimated the difficulties a system developer must contend with in the design of a system at the higher frequency of 40 GHz. The same performance characteristics at 40 GHz as that achievable at 28 GHz is difficult to achieve due to the increased difficulty of obtaining the same frequency stability and purity at the higher frequencies. Accommodating the increased attenuation due to rain at 40 GHz requires more than maintaining flexibility in system design. The system designer must increase the system EIRP to maintain the same hub ranges at frequencies where generating power of any significant level is difficult at best with today's technology.

Hughes also goes further to claim that there are at least three options available to the LMDS designer "to achieve the same or equivalent performance at 40 GHz with minimum, or no, changes to the technical parameters of the 28 GHz system design".

These are reviewed and comments are provided below.

A) maintaining the same transmit power (100W), transmit antenna size, cell size, and receiver antenna size, but accepting a slightly lower availability;

This option does not recognize that rain fall rates in the United States are not uniformly spread across the year. This changes the availability factor impact when one considers that the hours of system impact are compressed into three to six months of system operation with the highest rain fall rates occurring in the late afternoon and evening hours. Thus, what might seem as only a slightly lower availability on an annual basis becomes unacceptable for a practical system.

B) maintaining the same transmit power (100W), cell size, receiver antenna size, and availability, but increasing the transmit antenna gain from 10 to 18 dB;

The hubs of an LMDS system must provide omen directional coverage. Thus, their antenna gains can not be increased by 8 dB without negatively affecting the characteristics of the antenna. Thus, this option is not realistic for a LMDS system.

C) maintaining the same transmit power (100W), cell size, transmit antenna size, and availability, but increasing the receive antenna size from 6.9 to 12 inches.

Increasing the receive antenna size for the subscriber CPE to increase the gain would decrease the beamwidth of the antenna. The 28 GHz antenna are designed to accommodate beamwidths of 3 to 4 degrees. Further decrease in beamwidth to achieve high gains increase the difficulty of installation and compromises the stability of the antenna in winds. Also, with the narrow beamwidth proposed, the stability of the structure on which the antenna is mounted becomes a consideration in system operation. Thus, this option is not acceptable due to the increased difficulty of installation and operation over time.

All of the above options assume that the same transmitter power (100W) is maintained. It must be recognized the increased difficulty that this imposes on the system designer and operator at 40 GHz. This level of power generation is not insignificant at 40 GHz and present a major technological and cost barrier to the LMDS equipment designer and system operator.

Thus, Hughes view and claim that frequencies above 40 GHz will be technically and operationally similar to the services now proposed for LMDS at 28 GHz with essentially the same performance characteristics as the 28 GHz band can not be shared by Texas Instruments.

Teledesic stated that their study confirms that LMDS at 41 GHz is technically comparable to operate in the 41 GHz band. They further stated that for the 41 GHz band operation is

"readily achievable from both a propagation standpoint and an equipment standpoint."

"That propagation characteristics are similar."

"Thus, deployment of LMDS in the 41 GHz band rather than in the Ka band will not pose additional technical or economic burdens on LMDS operation."

This circular argument is similar to many offered by Teledesic during the 28 GHz NRMC committee and working group meetings. Although it is true that propagation characteristics are similar in the two bands in clear weather, this does not hold during times of rain. Thus, the deployment of LMDS in the 41 GHz band rather than in the Ka band will pose significant additional technical and economic burdens on LMDS operation.

Teledesic commented that their review also indicates that the equipment necessary to implement LMDS at 41 GHz is comparable to that proposed to be employed for LMDS at 28 GHz.

However, when one studies their reviews, they compared high level functional block diagrams to conclude that the equipment necessary to implement LMDS at 41 GHz is comparable. If one were to look at the system design requirements for systems in the two bands one would quickly learn that there are major differences in system and equipment parameters between the 28 GHz and 41 GHz systems. Thus, Teledesic comment that the equipment necessary to implement LMDS at 41 GHz versus 28 GHz is comparable can not be supported with a technically sound argument but only from a superficial functional comparison.

Teledesic also makes the argument that "Operation of the Proposed LMDS in the 40.5-42.5 GHz Band is Technically and Economically Comparable to Operation in the Ka Band." They appear to make this claim based on the following:

"Propagation characteristics of LMDS operations in the Ka band and in the 41 GHz band are similar. Thus,....41 GHz will not pose additional technical or economic burdens on LMDS operators."

This comment by Teledesic fails to recognize the technical differences and difficulties of designing and implementing the equipment for operation in the 41 GHz band relative to equipment developed for 28 GHz. Teledesic failed to recognize the frequency generation difficulties such as frequency stability and phase noise at 41 GHz. Also, they do not recognize the differences at the subscriber terminal that would exist in the antenna, preamplifier, down converter and local oscillator for a 40 GHz system. This translates directly in equipment and system cost which will be an economic burden on the LMDS system operator if not an insurmountable barrier to system implementation.

Teledesic proposes to solve the increased rain attenuation and reduced system availability by "assuming a more realistic cell size at the 41 GHz frequency with a even less than 3 mile cell radius."

This proposal to reduce the LMDS cell size indicates Teledesic's lack of understanding of how this directly impacts the cost of system installation and operational cost. It has been estimated that reduced cell radius at 40 GHz would

require seven times more Nodes to cover the same geographical area as a system operating at 28 GHz. Texas Instruments has been told by one of their potential LMDS customers that this alone would change their cost model to cause them to rethink deployment of an LMDS system.

- LMDS ALLOCATION AT 40 GHZ WOULD NOT BE EQUIVALENT TO THE EUROPEAN ALLOCATION FOR MVDS

Texas Instruments has reviewed the reports that support the European allocations at 40 GHz and have concluded that those are based on very light rain falls. In fact the 3mm/hr that these allocations are based on do not even come close to the 25 mm/hr minimum rain fall rates used for system design in the United States. The proposed system in the European 40 GHz band has been available for licenses since January 1991 but none have yet to be implemented on a commercial basis. **Thus, to propose that the United States should move the 28 GHz LMDS systems to 40 GHz would only serve to prevent the American public from sharing in the many benefits offered by LMDS.**

CONCLUSIONS

Texas Instruments believes that the Commission's proposed action to open for commercial development and use of the frequency bands above 40 GHz for new radio applications is to be commended. Texas Instruments is disappointed to see the FSS proponents use this forum to propose moving the 28 GHz LMDS applications to 40 GHz. The FSS proponents have claimed that shifting LMDS from 28 GHz to 40 GHz would be a win-win situation. The LMDS proponents can not view such action in the same manner due to the lack of technical maturity of the technology, the increased technical difficulties of equipment development and operation of 40 GHz systems and, the severe economic burden that would result at these higher frequencies. **Thus, any attempt to move the 28 GHz activity from 28 GHz to 40 GHz would be a loss to the American public and the LMDS proponents. Clearly, this is not a win-win situation for anyone associated with the LMDS activities or for the ultimate beneficiary -the American public.**

The 40 GHz band is not technically and operationally comparable with 28 GHz operation as claimed by the FSS proponents. **There are significant differences in both the equipment requirements, in their design, and in LMDS system deployment and operation at 40 GHz that would have substantial economic impact. This economic impact for the development and operation at 40 GHz is significant enough to essentially delay the implementation of LMDS in the United States for an unpredictable amount of time.**

The FSS proponents have attempted to claim that LMDS allocation at 40 GHz would be consistent and equivalent to the European allocation for MVDS. **The European community has recognized the limitations associated with operation at 40 GHz as is evident from the lack of commercial 40 GHz systems in Europe today. The rain fall differences between Europe and the United States is different enough such that any comparison of operational similarities at 40 GHz in the two geographical regions is irrelevant.**

If the Commission's solution to the 28 GHz rulemaking is to move either LMDS or FSS to 40 GHz then it should consider moving the FSS systems proposed for the 28 GHz band. These FSS uplinks have been demonstrated to operate successfully above 40 GHz and do not have to contend with the same rain fall and system limitations as the terrestrial LMDS systems.

Texas Instruments looks forward to the resolution of the LMDS/FSS 28 GHz issues on their own merits and benefits to the United States. The new broadband wireless services that can be provided by LMDS systems at 28GHz could be a reality in the very near term if prompt resolution could be reached by the Commission.